Addressing leishmaniasis in Tunisia's changing climate

It is widely recognized that climate change will have major impacts on human health, by increasing weather-related disasters and changing the distribution of water- and vector-borne diseases. But our attempts to adapt to the effects of climate change may themselves pose unforeseen health risks.

By the numbers

90 thousand cases of ZCL diagnosed in Tunisia since 1982

111 percent increase in ZCL cases in Sidi Bouzid from 2009 to 2010

2.1 °C projected temperature increase in Tunisia by 2050

In Tunisia, a research team led by the National Observatory for New and Emerging Diseases and the Tunisian Agency for Technical Cooperation is examining how climate change, and local attempts to deal with water scarcity, may increase exposure to *zoonotic cutaneous leishmaniasis* (ZCL). This scarring disease, caused when the *Leishmania major* parasite is transmitted by sandfly bites, can cruelly disfigure those infected. A raised skin lesion develops, sometimes months later, at the site of the bite. The sore ulcerates and is prone to infection. For women, whose social standing and sense of self-worth are more affected by their appearance, the lasting marks of the disease can be devastating.

The disease is endemic in Tunisia, with occasional outbreaks in the centre and southwest. The disease is susceptible to changes in climate and other factors that affect soil temperature and humidity, such as farm irrigation and dam construction. New settlements can also bring non-immune populations into contact with the parasites, leading to new outbreaks.

The disfiguring scars caused by *zoonotic cutaneous leishmaniasis* can have psychological and social consequences for its victims.

Counting sand rats in the field. These rodents serve as a disease reservoir. *All photos courtesy of the National Observatory for New and Emerging Diseases*

Research team members preparing traps for a vector count.

The sandfly *P. papatasi* transmits the parasite that causes ZCL.

Using a multidisciplinary ecosystem approach, the project is testing options to reduce the vulnerability of local populations. To date, the team has made significant progress in understanding the local dynamics favouring disease transmission and in laying the groundwork for an early warning system based on monitoring of climate information, disease epidemiology, and changes in the vegetation cover. They have also closely examined how local irrigation systems may affect farmers' exposure to vectors. Recognizing that irrigation practices are a likely risk factor, researchers feel it is critical to work with farmers to find ways to reduce exposure.

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The progress of this project is all the more remarkable this year, given that the study zone — in the governorate of Sidi Bouzid — was at the centre of the recent popular uprising in Tunisia. The research team continued work in extremely difficult circumstances to consolidate findings and ensure there would be no data gaps.

Dealing with water scarcity in a warming climate

From 1976 to 2000, Tunisia's climate warmed by over 1° C, with increases in both drought and flooding. Global climate projections, when applied to Tunisia, suggest an average temperature increase by 2050 of 2.1° C.

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To address recurring droughts, Tunisia adopted a strategy of harnessing water during flood years for use during subsequent droughts, by building hillside dams and lakes. At the same time, its national agricultural strategy has encouraged perimeter irrigation in rural areas. These systems, and rising temperatures, provide ideal breeding conditions for sandflies, and a species of sand rat (*Psammomys obesus*) that serves as a disease reservoir. They also bring people in contact with the vectors. In 1982–83, an outbreak of leishmaniasis around the newly constructed Sidi Saad dam illustrated the risk. Over the next six years, the disease spread to two-thirds of Tunisia's territory.

The team undertook bioclimatic analysis in the Sidi Bouzid study zone to better understand how climate change may benefit the vector and the disease. They found that with the current warming trend, the hot season is prolonged and cuts into the two intermediate seasons, spring and fall. The growing length of the hot season and its overlap with the rainy season means the period of time favourable to ZCL transmission is increasing.

Understanding how irrigation can increase risk

To enhance their crops' water uptake, farmers irrigate when the weather is cool, either early in the morning or overnight. In doing so, they expose themselves to the disease, as these times coincide with the activity of the nocturnal sandfly that transmits leishmaniasis. Methods of storing manure can also provide favourable conditions for the insects. The risk is further compounded when faulty equipment or poor training results in large volumes of water wasted on plots. The added soil humidity favours sandfly reproduction.

According to existing scientific literature, the sandfly *P. papatasi*, which is the vector for ZCL, was believed to be active from 8 p.m. to midnight. To determine the precise timing of farmers' risk exposure, the research team looked at both the spatial distribution of the vector and farmer irrigation practices. In counts carried out at various biotopes in the study area, the research team found that *P. papatasi* was actually more active from 11 p.m. to 4–5 a.m., with peak activity from midnight to 1 a.m.

Researchers found the sandfly vector was more active from 11 p.m. to 4-5 a.m., later than previously thought.

The team observed farmers' irrigation practices at two sites, El Hichria and Ouled Mhamed. The timing of irrigation differed at these two sites, with farmers in El Hichria watering from around midnight to 8 a.m. in July and August, while in Ouled Mhamed, irrigation use lasted from 6 a.m. to 6 p.m. in July

Faces behind the research

***Dr. Mohamed Kouni Chahed,** project leader, Tunisia's National Observatory for New and Emerging Diseases*

Mohamed Chahed, a professor and specialist in preventative medicine, has served as General Director of Tunisia's National Observatory of New and Emerging Diseases and as the Chief Medical Officer of the communicable diseases control unit of the Ministry of Health.

According to Dr. Chahed, this project has provided a unique opportunity to apply new approaches to a long-standing challenge. "We've been working on this disease now for over 20 years, trying to find solutions. There has been a lot of effort to develop a vaccine, but the ecosystem approach allows us to look at the interaction between climate and the biotopic determinants behind outbreaks of ZCL.

"I was very enthusiastic about taking part in this program because it pushed us beyond earlier, more academic research. The multidisciplinary approach also makes for exciting interaction among specialists from a range of backgrounds."

Given the importance of influencing farmer behaviour and informing local health officials, the team put in place a local project committee, including a core group that helped collect data. In spite of the upheaval in Tunisia this year, Dr. Chahed is proud to say they never missed a day. As a result, he says, "We now have very complete data sets, including satellite images of the vegetation cover. This provides an excellent base for an epidemiological early warning system, and we are seeking ways to continue this vital research beyond the life of this project."

and from 5 a.m. to 4 p.m. in August. The avoidance of nighttime hours in Ouled Mhamed, and the fewer total hours of irrigation, may be attributed to farmers' use of a more efficient drip and sprinkler system. In contrast, surface canal irrigation in El Hichria, mainly of olive and pomegranate trees, involves a lot of water loss. It increases soil humidity and adds to the time needed to irrigate. The situation has forced those in charge to schedule nighttime hours for irrigation. In Ouled Mhamed, farming activity centres on only end-of-season olive production, and there is less overall pressure on the irrigation system. The sprinkler and drip systems limit soil saturation and reduce the need for nighttime irrigation.

Irrigation itself is not the key risk factor, but the hydraulic systems, and the scheduling and management of collective irrigation, must be adapted to limit exposure to ZCL.

Based on these observations, farmers in El Hichria were considered to be relatively exposed to the disease by watering between midnight and 5 a.m., while the farmers at Ouled Mhamed were considered at zero risk. Their behaviour and subsequent risk exposure stem from both their crops and their irrigation methods. Researchers concluded from these observations that irrigation itself is not the determining risk factor, but the hydraulic systems, and the overall scheduling and management of collective irrigation, must be adapted to limit exposure to ZCL.

A collective irrigation site within the study zone.

Building community awareness

Given the risk, building community understanding and capacity is a major concern. The team is working with the regional farmers union and local agricultural development groups through which most farmers in Sidi Bouzid are organized. Researchers met extensively with agricultural development officials to present and discuss the results of their observations of irrigation practices. With the help of local health care providers, they surveyed the population on their perceptions of climate change, and presented results at Public Health Day events organized by the Regional Health Directorate in May 2010. Further public awareness events are planned with the regional farmers union.

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The project Analysis of the health impacts of climate change adaptation strategies: the case of zoonotic cutaneous leishmaniasis *from* Leishmania Major *in Tunisia illustrates progress toward CCAA outcome area 2:* **At-risk groups, policymakers, and researchers share learning and expertise on climate vulnerability and poverty.**

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